PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-249560
(43)Date of publication of application : 26.09.1995

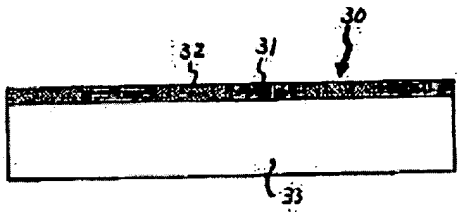
(51)Int.Cl. H01L 21/027
G03B 27/32
G03F 1/08
G03F 7/20

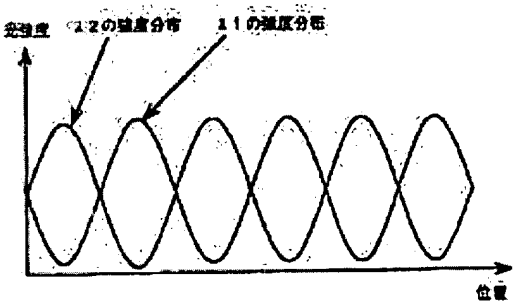
(21)Application number : 06-038794
(22)Date of filing : 09.03.1994

(71)Applicant : NIKON CORP
(72)Inventor : OKI YASUSHI
SHIBUYA MASATO
KOMATSU MASAYA
OZAWA TOSHIHIKO

(54) EXPOSURE METHOD AND DEVICE

(57)Abstract:
PURPOSE: To eliminate the movable part for the relative positional change between the sensing material and the image formed thereon by a method wherein patterns are provided on reticles by using two or more exposure wavelengths and optical filters having different transmittivities to the exposure wavelengths.
CONSTITUTION: A linearly periodical pattern is formed of an optical thin film comprising an interference filter on a reticle substrate 33. A part 31 having the characteristics of transmitting $\lambda 1$ but not transmitting $\lambda 2$ and another part 32 having inverse characteristics of not transmitting $\lambda 1$ but transmitting $\lambda 2$ of the same width are alternately arranged. The image of this reticle pattern is formed by illumination light of the wavelength of $\lambda 1$ and formed by the light $\lambda 2$. Through these procedures, the periodical pattern in the distribution of light intensity of light inversed in bright and shade to respective wavelengths can be taken.





* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]By exposing multiple times from which light intensity distribution on a sensitization raw material differs using that in which latent image reaction concentration has a nonlinear sensitivity characteristic to incident light intensity as a sensitization raw material, An exposure method illuminating the original edition which provided a component which makes this different wavelength beyond 2 ** penetrate selectively in an exposure method which enables formation of a pattern of high resolution exceeding a resolution limit of a projection optical system using light of two or more different wavelength as a light for exposure to be projected.
[Claim 2]The exposure method according to claim 1 using two or more sensitization raw materials which have a sensitivity characteristic different, respectively as the aforementioned sensitization raw material.
[Claim 3]In a projection aligner with which the latent image reaction concentration has a nonlinear sensitivity characteristic to incident light intensity, only the specified quantity moves a sensitization raw material and the original edition to be projected relatively for every exposure, and a sensitization raw material repeats exposure of multiple times, and forms latent image concentration distribution of a pattern more detailed than a pattern of the original edition to be projected,
A projection aligner having a selectivity transmission member characterized by comprising the following.
A light source which emits light of two or more different wavelength as a light for exposure.
Transmissivity which has an illumination-light study system which illuminates the aforementioned original edition to be projected with a beam of light emitted from the aforementioned light source and from which the aforementioned original edition to be projected differs to the two or more aforementioned wavelength.

[Claim 4]The exposure device according to claim 3, wherein the aforementioned illumination-light study system has a wavelength selection means to penetrate light of two or more different wavelength selectively as a light for the aforementioned exposure.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to the exposure device used for manufacture of a semiconductor device or a liquid crystal plate especially a projected type exposure device, and a projection exposure method.
[0002]
[Description of the Prior Art]A thing with a nonlinear sensitivity characteristic is used for incident light intensity as a sensitization raw material, About the technology which enables formation of a more detailed pattern exceeding the resolution limit of the ordinary one-shot exposure, the inventors of this invention have already indicated in Japanese Patent Application No. 5-236031 by carrying out multiple-times exposure, changing the light intensity distribution on a sensitization raw material to this.
[0003]
[Problem to be solved by the invention]In the super resolution technology indicated previously, it was required to move a reticle and a wafer relatively for every exposure of multiple times. Changing the relative position of the original edition to be projected, a sensitization raw material, and ** for the purpose, or exchanging the original edition to be projected etc. needed to be operated. However, in any case, very exact alignment was required, and in order for alignment to become difficult and to require time, there was a problem that improvement in a throughput could not be expected.
[0004]In this invention, the movable part for relative location change with the image formed on a sensitization raw material and a sensitization raw material is lost, and it aims at doing the work of the alignment like **** unnecessary.
[0005]
[Means for Solving the Problem]A pattern on a reticle is constituted using an optical filter which has different transmissivity to these two or more different exposure wavelengths using two or more exposure wavelengths for solution of the aforementioned problem. A sensitization raw material which comprises two or more sorts of resists which have a sensitivity characteristic which is different to the two or more aforementioned different wavelength depending on the case is used.
[0006]By specifically exposing multiple times from which light intensity distribution on a sensitization raw material differs using that in which latent image reaction concentration has a nonlinear sensitivity characteristic to incident light intensity as a sensitization raw material, In an exposure method which enables formation of a pattern of high resolution exceeding a resolution limit of a projection optical system, it is an exposure method illuminating the original edition which provided a component which makes this different wavelength beyond 2 ** penetrate selectively to be projected using light of two or more different wavelength as a light for exposure.
[0007]Two or more sensitization raw materials which have a sensitivity characteristic different, respectively are used as the aforementioned sensitization raw material. As for a sensitization raw

material, the latent image reaction concentration has a nonlinear sensitivity characteristic to incident light intensity, In a projection aligner which only the specified quantity moves a sensitization raw material and the original edition to be projected relatively for every exposure, repeats exposure of multiple times, and forms latent image concentration distribution of a pattern more detailed than a pattern of the original edition to be projected, It has a light source which emits light of two or more different wavelength as a light for exposure, The aforementioned original edition to be projected by having a selectivity transmission member which has different transmissivity to the two or more aforementioned wavelength, and illuminating the aforementioned original edition to be projected with a beam of light emitted from the aforementioned light source, Even if only the specified quantity does not move relatively the aforementioned sensitization raw material and the aforementioned original edition to be projected for every exposure, a projection aligner forming latent image concentration distribution of a detailed pattern is proposed.

[0008]

[Function]An operation of this invention is explained based on the 1st working example by this invention shown in drawing 2 and drawing 3. The thing of a one-dimensional period pattern is used as the **** projecting original edition 30 shown in drawing 2 using the different exposure wavelength lambda 1 and lambda 2. As for the period pattern, the portion 32 of the penetration is constituted [exposure wavelength / lambda 1 / exposure wavelength / lambda 2 / the penetration and / exposure wavelength / lambda 2 / un-penetrating and] by turns in the unpenetrated portion 31 and the exposure wavelength lambda 1. 180 degrees of light intensity distribution made in the image surface as shown in drawing 3 are reversed by the case where it projects using this original edition to be projected with the case where it projects with the exposure wavelength lambda 1, and the exposure wavelength lambda 2. That is, the light intensity distribution which did not need a mechanical shift but light and darkness reversed can be formed.

[0009]It is effective that lambda 1 and lambda 2 generally add an unpenetrated portion for a penetration, lambda 1, and lambda 2 as the technique of raising the flexibility of the pattern of the original edition to be projected in addition to the portions of lambda1 penetration, lambda2 un-penetrating, lambda1 un-penetrating, and lambda2 penetration. When exposing a complicated pattern, it is required that independent light intensity distribution should generally completely be built to the wavelength lambda1 and lambda2. In such a case, as shown in drawing 4, it is also considered that it becomes complicated to form a pattern in two or more portions. When wavelength is two, it is still good, but if it becomes more than three or it, complicated-ization of a pattern will become still more intense. If the synthetic sensitization raw material which comprises two or more sorts of sensitization raw materials which have the different sensitization characteristic to two wavelength is used as a sensitization raw material here, a pattern can be formed more easily.

[0010]Although exposed on the sensitization raw material which is not exposed on other wavelength although exposed on the wavelength lambda 1, and the wavelength lambda 2, the synthetic sensitization raw material which comprises two or more sorts of sensitization raw materials which have a different sensitivity characteristic like the sensitization raw material which is not exposed is used for other wavelength. In this case, if it illuminates on the wavelength lambda 1, light will penetrate only from lambda1 transparent part on the original edition to be projected, and the 1st light intensity distribution will be formed of this light. If it next illuminates on the wavelength lambda 2, it will not be concerned with penetration un-penetrating of lambda 1, but light will penetrate only from lambda2 transparent part, and the 2nd light intensity distribution will be formed of this light. These 1st and 2nd light intensity distribution makes two ingredients contained in a synthetic sensitization raw material expose independently.

[0011]

[Working example]Drawing 1 shows the schematic structure figure of the whole exposure device in this invention. The illumination luminous flux from the light source 11 which can emit two or more different wavelength, It is condensed by the elliptic mirror 12, is led to the collimating lens 14 by the

mirror 13, it becomes a parallel pencil mostly, and enters into the fly eye integrator 15 through the interference filter 21 as a removable wavelength selection means. The light flux which ejected the fly eye integrator 15 is led to the main capacitor 17 by the mirror 16, and illuminates the reticle 18 as the original edition to be projected uniformly. Projection exposure of the predetermined pattern on the original edition 18 to be projected is carried out on the wafer 20 in which the sensitization raw material was applied by the projection optical system 19. By exchanging the interference filter 21 for a different thing of a wavelength characteristic like the arrow in a figure, the wavelength lambda 2 is chosen as an exposure wavelength by the wavelength lambda 1 and time [2nd] exposure by time [1st] exposure. As for the projection optical system 19, it is natural here to have removed the chromatic aberration to these two wavelength lambda 1 and lambda 2.

[0012]Here, although the interference filter 21 has been arranged in the illumination-light study system between the collimating lens 14 and the fly eye integrator 15, if the arrangement place of the interference filter 21 does not affect image formation performance, anywhere in an exposure device may be sufficient as it. It is not possible to choose the exposure wavelength lambda 1 of the 1st time and the exposure wavelength lambda 2 of the 2nd time with a glass filter with a dichroic mirror or an absorption feature, etc. instead of the interference filter 21 arranged in an exposure device also until it says.

[0013]Drawing 2 is an outline section block diagram of a reticle as the 1st working example as mentioned above.

It is an enlarged drawing of the reticle 18 in drawing 1 as the original edition to be projected.

On the reticle substrate 33, the one-dimensional period pattern is formed with the optical thin film which constitutes an interference filter. As shown in drawing 2, the portion 31 (shadow area) which has lambda2 characteristic which is not penetrated [lambda1 penetration and], and the portion 32 (scattered portion) which has the characteristic of lambda1 un-penetrating and lambda2 penetration conversely are located in a line by turns by the same width. After imaging this reticle pattern by the illumination light on the wavelength lambda 1, if it images by the illumination light of lambda 2, as shown in drawing 3, the period pattern of the light intensity distribution which light and darkness reversed to each wavelength will be obtained. In such a situation, if latent image reaction concentration uses the sensitization raw material which has a nonlinear sensitivity characteristic to the wavelength lambda 1 and the incident light intensity of lambda 2, the detailed pattern exceeding a resolution limit will be obtained.

[0014]In the above-mentioned working example, it is a case where the reticle as the original edition to be projected comprises the one-dimensional period pattern. However, in a general reticle, when the one-dimensional period pattern is comprised simply, it is few, and a complicated pattern is comprised in many cases. Therefore, the 2nd working example that enlarged flexibility of the pattern which can add and use on a pattern the portion which makes both wavelength of both penetrate, and the portion which presupposes un-penetrating both wavelength of both is shown. Drawing 4 shows the sectional view of the reticle used in the 2nd working example of this invention. The portion 41 (scattered portion) into which this reticle 40 has lambda2 characteristic which is not penetrated [lambda1 penetration and], Conversely, the portion 42 (shadow area) which has the characteristic of lambda1 un-penetrating and lambda2 penetration was located in a line by turns, and the perfect transmission part 44 (white-painted part) whose perfect shield parts 43 (black-painted part) which did not penetrate lambda 1 and lambda 2 lambda 1 and lambda 2 are penetrations at the left end side is further added to the right end. Using this reticle, if it images by the wavelength lambda 1 and the illumination light of lambda 2, respectively, the pattern of the **** light intensity distribution shown in drawing 5 will be obtained.

[0015]In such a situation, if latent image reaction concentration uses the sensitization raw material which has a nonlinear sensitivity characteristic to the wavelength lambda 1 and the incident light intensity of lambda 2, the detailed pattern exceeding a resolution limit will be obtained. The 3rd working example using the resist which is a synthetic sensitization raw material produced by mixing

the sensitization ingredient 1 which has sensitivity only to the wavelength lambda 1, and the sensitization ingredient 2 which has sensitivity only to the wavelength lambda 2 is shown below.
[0016]The outline section block diagram of a reticle used for the 3rd working example is shown in drawing 6. As for this reticle 60, only the wavelength lambda 1 forms the first pattern on the reticle substrate 61 with un-penetrating and the optical thin film 62 which has the characteristic of the other wavelength penetration, If only the wavelength lambda 2 forms the second pattern with un-penetrating and the optical thin film 63 which has the characteristic of the other wavelength penetration and these both patterns are piled up, the sensitization ingredient 1 of a resist will form only the latent image of the first pattern, and the sensitization ingredient 2 will form only the latent image of the second pattern. Since, as for the resist, latent image reaction concentration has a nonlinear sensitivity characteristic to incident light intensity at this time, the detailed pattern exceeding a resolution limit is obtained.
[0017]This technique can be applied also when an exposure wavelength becomes three or more kinds clearly. As for the two reticle patterns 62 and 63 shown in drawing 6, it is preferred to set an interval suitably and to be formed on both sides of the transparent member 64 etc. About an interval, if the spectral characteristic required of the reticle 60 is satisfied, the smaller one is good, and it is desirable more preferably to be subsided in the depth of focus of a projection optical system. However, even if it is not in the depth of focus, it can expose by correction of few focusing positions, and the feature of this invention is not lost in this case, either.
[0018]The 4th working example using the resist which is a synthetic sensitization raw material produced by mixing two different monochromatic light sources and two sensitization ingredients from which a wavelength sensitivity characteristic differs is shown below. Here, wavelength becomes large at the order of lambda 1, lambda 2, lambda 3, lambda 4, lambda 5, and lambda 6, and each wavelength is not the same size. Light sources used by this example are the laser L1 which emits monochromatic light of the wavelength lambda 2, and the laser L2 which emits monochromatic light of the wavelength lambda 5.
It is made to have irradiated with a beam of light which mixed these monochromatic light on a reticle.

[0019]The reticle comprises the one-dimensional period pattern in which the portion into which near the wavelength lambda 2 has wavelength the characteristic which is not penetrated [a penetration and / other], and the portion into which near the wavelength lambda 5 has wavelength the characteristic which is not penetrated [a penetration and / other] were formed by turns by the same width on the reticle substrate. At this time, the resist which is a synthetic sensitization raw material which comprises the sensitization ingredient 1 which has sensitivity from the **** wavelength lambda 1 shown in drawing 7 formed on the substrate to lambda 3, and the sensitization ingredient 2 which has sensitivity from the wavelength lambda 4 to lambda 6 is used as a resist.
[0020]If one-shot exposure is performed using this resist and the two aforementioned monochromatic light sources, although there is sensitivity in the wavelength lambda 2, in order that there may be no sensitivity in the wavelength lambda 5, regardless of the light intensity distribution formed of the wavelength lambda 5, of the sensitization ingredient 1, the image of the light intensity distribution formed of the wavelength lambda 2 will turn into a latent image. Contrary to this, of the sensitization ingredient 2, although there is sensitivity in the wavelength lambda 5, in order that there may be no sensitivity in the wavelength lambda 2, regardless of the light intensity distribution formed of the wavelength lambda 2, the image of the light intensity distribution formed of the wavelength lambda 5 turns into a latent image. Since, as for the resist, latent image reaction concentration has a nonlinear sensitivity characteristic to incident light intensity at this time, the detailed pattern exceeding a resolution limit is obtained.
[0021]Although one-shot exposure was simultaneously performed in the 4th working example using the light of different wavelength, a different thing exposed un-simultaneous for every wavelength is

not possible, either, also until it says. The wavelength sensitivity characteristic of the sensitization ingredient 1 and the sensitization ingredient 2 not only in that to which wavelength becomes large at the order of the above lambda 1, lambda 2, lambda 3, lambda 4, lambda 5, and lambda 6, If a resist called lambda4(short wavelength end of sensitization ingredient 2)>lambda2 (exposure wavelength from the laser L1) and lambda5(exposure wavelength from laser L2)>lambda3 (long wavelength end of the sensitization ingredient 1) is used even when set to lambda4(short wavelength end of sensitization ingredient 2)<lambda3 (long wavelength end of the sensitization ingredient 1), The same result as the 4th above-mentioned working example is obtained.

[0022]

[Effect of the Invention]Thus, according to this invention, without the reticle and wafer which need exact alignment horizontal ** carrying out, and performing ** reticle replacement etc., two or the independent image beyond it can be formed on a sensitization raw material, and the necessity for projecting original edition exchange will be reduced substantially.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]An exposure device in this invention
[Drawing 2]The outline section block diagram of the reticle in the 1st working example
[Drawing 3]Light intensity distribution on the image surface in the 1st working example
[Drawing 4]The outline section block diagram of the reticle in the 2nd working example
[Drawing 5]Light intensity distribution on the image surface in the 2nd working example
[Drawing 6]The outline section block diagram of the reticle in the 3rd working example
[Drawing 7]The figure of the wavelength characteristic of the sensitization raw material in the 4th working example

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平7－249560

(43)公開日　平成７年(1995)９月26日

(51)Int.Cl.[6]	識別記号	庁内整理番号	Ｆ Ｉ	技術表示箇所
Ｈ０１Ｌ　21/027				
Ｇ０３Ｂ　27/32	Ｆ			
Ｇ０３Ｆ　1/08	Ｄ			
		7352－4M	Ｈ０１Ｌ　21/ 30	５０２　Ａ
		7352－4M		５０２　Ｒ

審査請求　未請求　請求項の数４　ＯＬ　（全 5 頁）　最終頁に続く

(21)出願番号　特願平6－38794

(22)出願日　平成６年(1994)３月９日

(71)出願人　000004112
株式会社ニコン
東京都千代田区丸の内３丁目２番３号

(72)発明者　大木　裕史
東京都千代田区丸の内３丁目２番３号　株式会社ニコン内

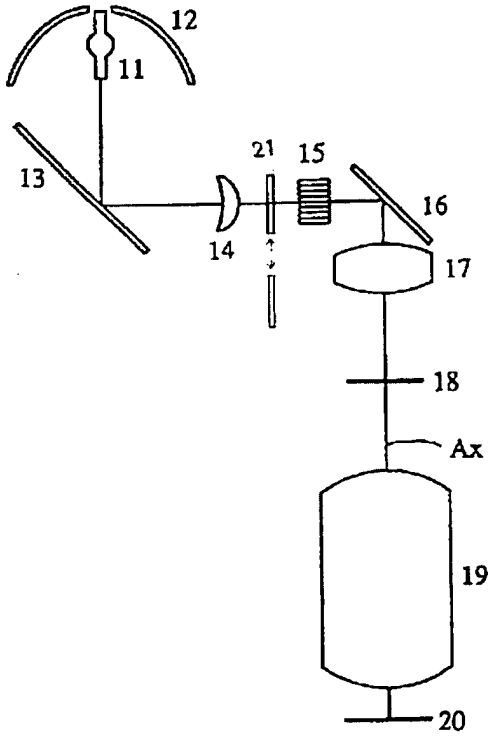
(72)発明者　渋谷　眞人
東京都千代田区丸の内３丁目２番３号　株式会社ニコン内

(72)発明者　小松　雅也
東京都千代田区丸の内３丁目２番３号　株式会社ニコン内

最終頁に続く

(54)【発明の名称】　露光方法及び露光装置

(57)【要約】
【目的】感光素材と感光素材上に形成される像との相対的位置変化のための可動部分を無くし、位置合わせの作業を不要にする。
【構成】露光波長を２つ以上用い、これら２つ以上の異なる露光波長に対し異なる透過率を有する光学的フィルタを用いて、レチクル上のパターンを構成する。また、場合によっては前記２つ以上の異なる波長に対し異なる感度特性を有する２種以上のレジストから成る感光素材を用いる。



【特許請求の範囲】
【請求項１】感光素材として潜像反応濃度が入射光強度に対して非線形な感度特性を持つものを用い、感光素材上での光強度分布が異なる複数回の露光を行うことにより、投影光学系の解像限界を越える高解像のパターンの形成を可能とする露光方法において、露光用の光として２つ以上の異なる波長の光を用い、該２つ以上の異なる波長を選択的に透過させる部材を設けた被投影原版を照明することを特徴とする露光方法。
【請求項２】前記感光素材として、それぞれ異なる感度特性を有する２つ以上の感光素材を用いたことを特徴とする請求項１記載の露光方法。
【請求項３】感光素材はその潜像反応濃度が入射光強度に対して非線形な感度特性を有し、各露光毎に感光素材と被投影原版とを相対的に所定量だけ移動して複数回の露光を繰り返し、被投影原版のパターンよりも微細なパターンの潜像濃度分布を形成する投影露光装置において、露光用の光として２つ以上の異なる波長の光を放射する光源と、前記光源から放射した光線により前記被投影原版を照明する照明光学系とを有し、前記被投影原版は前記２つ以上の波長に対して異なる透過率を有する選択性透過部材を有することを特徴とする投影露光装置。
【請求項４】前記照明光学系は、前記露光用の光として２つ以上の異なる波長の光を選択的に透過する波長選択手段を有していることを特徴とする請求項３記載の露光装置。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明は、半導体素子や液晶板の製造に用いられる露光装置、特に投影型露光装置および投影露光方法に関する。
【０００２】
【従来の技術】感光素材として入射光強度に非線形な感度特性を有したものを用い、これに感光素材上での光強度分布を変化させながら複数回露光することによって通常の一括露光の解像限界を超えてより微細なパターンの形成を可能とする技術については、すでに特願平5-236031において本発明の発明者らが開示している。
【０００３】
【発明が解決しようとする課題】先に開示した超解像技術においては、複数回の露光毎にレチクルとウェハとを相対的に移動させることが必要であった。このためには被投影原版と感光素材とのの相対的な位置を変化させるか、被投影原版を交換するなどの操作が必要であった。しかし、いずれの場合も非常に正確な位置合わせが要求され、位置合わせが困難になると共に時間を要するためスループットの向上が望めないという問題があった。
【０００４】本発明では、感光素材と感光素材上に形成される像との相対的位置変化のための可動部分を無くし、上述の如き位置合わせの作業を不要にすることを目的とする。
【０００５】
【問題を解決するための手段】前記問題の解決のため、露光波長を２つ以上用い、これら２つ以上の異なる露光波長に対し異なる透過率を有する光学的フィルタを用いて、レチクル上のパターンを構成する。また、場合によっては前記２つ以上の異なる波長に対し異なる感度特性を有する２種以上のレジストから成る感光素材を用いる。
【０００６】具体的には、感光素材として潜像反応濃度が入射光強度に対して非線形な感度特性を持つものを用い、感光素材上での光強度分布が異なる複数回の露光を行うことにより、投影光学系の解像限界を越える高解像のパターンの形成を可能とする露光方法において、露光用の光として２つ以上の異なる波長の光を用い、該２つ以上の異なる波長を選択的に透過させる部材を設けた被投影原版を照明することを特徴とする露光方法である。
【０００７】また、前記感光素材として、それぞれ異なる感度特性を有する２つ以上の感光素材を用いる。更に、感光素材はその潜像反応濃度が入射光強度に対して非線形な感度特性を有し、各露光毎に感光素材と被投影原版とを相対的に所定量だけ移動して複数回の露光を繰り返し、被投影原版のパターンよりも微細なパターンの潜像濃度分布を形成する投影露光装置において、露光用の光として２つ以上の異なる波長の光を放射する光源を有し、前記被投影原版は前記２つ以上の波長に対して異なる透過率を有する選択性透過部材を有し、前記光源より放射した光線により前記被投影原版を照明することにより、各露光毎に前記感光素材と前記被投影原版とを相対的に所定量だけ移動しなくても微細なパターンの潜像濃度分布を形成することを特徴とする投影露光装置を提案する。
【０００８】
【作用】本発明の作用を図２及び図３に示した本発明による第１実施例に基づいて説明する。異なる露光波長λ１，λ２を用い、図２に示す如き被投影原版３０として一次元の周期パターンのものを用いる。更に、周期パターンは、露光波長λ１を透過かつ露光波長λ２を不透過の部分３１と、露光波長λ１を不透過かつ露光波長λ２を透過の部分３２が、交互に構成されている。この被投影原版を用い、露光波長λ１で投影した場合と露光波長λ２で投影した場合とでは、図３に示す如く像面にできる光強度分布が１８０°反転する。すなわち、機械的なシフトを必要とせず明暗の反転した光強度分布を形成することができる。
【０００９】被投影原版のパターンの自由度を高める手法として、一般にλ１透過かつλ２不透過及び、λ１不透過かつλ２透過の部分に加えてλ１，λ２ともに透過、λ１，λ２ともに不透過の部分を付け加えることが有効である。また、複雑なパターンの露光を行う場合、

一般に波長λ１とλ２に対して全く独立の光強度分布をつくることが要求される。このような場合、図４に示す如く、複数の部分でパターンを形成するのは繁雑になることも考えられる。波長が２つの場合はまだよいが、３つ、もしくはそれ以上になるとパターンの繁雑化はさらに激しくなる。ここで感光素材として２つの波長に対して異なる感光特性を有する２種以上の感光素材から成る合成感光素材を用いれば、より容易にパターンを形成することができる。

【００１０】波長λ１には感光するがその他の波長には感光しない感光素材、波長λ２には感光するがその他の波長には感光しない感光素材、というように異なる感度特性を有する２種以上の感光素材から成る合成感光素材を用いる。この場合、波長λ１で照明すると被投影原版上のλ１透過部分のみから光が透過し、この光によって第１の光強度分布が形成される。つぎに波長λ２で照明するとλ１の透過不透過に関わらずλ２透過部分のみから光が透過し、この光によって第２の光強度分布が形成される。これら第１、第２の光強度分布は合成感光素材に含まれる二つの成分を独立に露光させる。

【００１１】

【実施例】図１は本発明における露光装置の全体の概略構成図を示す。２つ以上の異なる波長を放射することが出来る光源１１からの照明光束は、楕円鏡１２により集光され、ミラー１３によりコリメータレンズ１４に導かれ、ほぼ平行光束となって着脱可能な波長選択手段としての干渉フィルタ２１を経てフライアイインテグレータ１５に入射する。フライアイインテグレータ１５を射出した光束はミラー１６によりメインコンデンサー１７に導かれ、被投影原版としてのレチクル１８を均一に照明する。被投影原版１８上の所定のパターンが投影光学系１９によって感光素材の塗布されたウエハ２０上に投影露光される。干渉フィルタ２１を図中の矢印のごとく異なる波長特性のものと交換することにより、第１回の露光では波長λ１、第２回の露光では波長λ２を露光波長として選択する。ここで投影光学系１９は、これら２つの波長λ１、λ２に対して色収差を取り除いてあることは当然である。

【００１２】尚、ここでは、干渉フィルタ２１をコリメータレンズ１４とフライアイインテグレータ１５との間の照明光学系中に配置したが、干渉フィルタ２１の配置場所は、結像性能に影響を与えなければ露光装置中のどこでも構わない。更に、露光装置中に配置される干渉フィルター２１の代わりに、ダイクロイックミラーや吸収特性を持つガラスフィルター等により第１回の露光波長λ１と第２回の露光波長λ２とを選択することが可能であることは言うまでも無い。

【００１３】前述した通り、図２は、第１実施例としてのレチクルの概略断面構成図であり、被投影原版としての図１におけるレチクル１８の拡大図である。レチクル基板３３上には、一次元の周期パターンが干渉フィルタを構成する光学薄膜によって形成されている。図２に示す如く、λ１透過かつλ２不透過の特性を有する部分３１（斜線部分）と、逆にλ１不透過かつλ２透過の特性を有する部分３２（点々部分）とが、同じ幅で交互に並んでいる。このレチクルパターンを波長λ１で照明光で結像した後、λ２の照明光で結像すると図３に示す如く、それぞれの波長に対し明暗の反転した光強度分布の周期パターンが得られる。このような状況において、潜像反応濃度が、波長λ１，λ２の入射光強度に対し非線形な感度特性を有している感光素材を用いると、解像限界を越える微細なパターンが得られる。

【００１４】上記の実施例では、被投影原版としてのレチクルが一次元の周期パターンから成っている場合である。しかし、一般的なレチクルでは、単純に一次元の周期パターンから成っている場合は少なく、複雑なパターンから成る場合が多い。そのため、パターン上に両波長をともに透過させる部分、および両波長をともに不透過とする部分を追加し、使用できるパターンの自由度を大きくした第２実施例を示す。図４は、本発明の第２実施例において使用するレチクルの断面図を示している。該レチクル４０は、λ１透過かつλ２不透過の特性を有する部分４１（点々部分）と、逆にλ１不透過かつλ２透過の特性を有する部分４２（斜線部分）が交互に並び、更に、λ１，λ２ともに不透過である完全遮蔽部４３（黒塗部分）が左端側に、λ１，λ２ともに透過である完全透過部４４（白塗部分）が右端に加わっている。該レチクルを用い、波長λ１，λ２の照明光でそれぞれ結像すると図５に示す如き光強度分布のパターンが得られる。

【００１５】このような状況において、潜像反応濃度が、波長λ１，λ２の入射光強度に対し非線形な感度特性を有している感光素材を用いると、解像限界を越える微細なパターンが得られる。また、波長λ１に対してのみ感度を持つ感光成分１と、波長λ２に対してのみ感度を持つ感光成分２とを混合して得られる合成感光素材であるレジストを用いた第３実施例を以下に示す。

【００１６】第３実施例に用いるレチクルの概略断面構成図を図６に示す。該レチクル６０はレチクル基板６１上に波長λ１のみ不透過かつそれ以外の波長透過の特性を有する光学薄膜６２で第一のパターンを形成し、波長λ２のみ不透過かつそれ以外の波長透過の特性を有する光学薄膜６３で第二のパターンを形成し、これら両パターンを重ねれば、レジストの感光成分１は第一のパターンの潜像のみを、感光成分２は第二のパターンの潜像のみを形成する。このとき、レジストは潜像反応濃度が入射光強度に対し非線形な感度特性を有しているので、解像限界を越える微細なパターンが得られる。

【００１７】なお、この手法は明らかに露光波長が３種類以上になった場合にも応用できる。図６に示す２つの

レチクルパターン６２と６３は、透明部材６４を挟むなど適当に間隔をおいて形成されるのが好ましい。間隔については、レチクル６０に要求される分光特性が満足されていれば小さい方がよく、より好ましくは、投影光学系の焦点深度内におさまっていることが望ましい。ただし、焦点深度内でなくてもわずかなフォーカス位置の修正で露光を行うことができ、この場合も本発明の特徴は失われない。

【００１８】更に、異なる２つの単色光源と、波長感度特性が異なる２つの感光成分を混合して得られる合成感光素材であるレジストを用いた第４実施例を以下に示す。ここでは、λ１，λ２，λ３，λ４，λ５，λ６の順に波長が大きくなり、それぞれの波長は同一の大きさではない。本実施例で用いる光源は、波長λ２の単色光を放射するレーザーＬ１と、波長λ５の単色光を放射するレーザーＬ２であり、これらの単色光を混合した光線をレチクル上に照射するようにしてある。

【００１９】レチクルは、レチクル基板上に波長λ２の付近のみ透過かつそれ以外の波長不透過の特性を有する部分と、波長λ５の付近のみ透過かつそれ以外の波長不透過の特性を有する部分が、同じ幅で交互に形成された一次元の周期パターンから成っている。このとき、レジストとして、基板上に形成された図７に示す如き波長λ１からλ３まで感度を有する感光成分１と、波長λ４からλ６まで感度を有する感光成分２とから成る合成感光素材であるレジストを用いる。

【００２０】該レジスト及び前記２つの単色光源を用いて一括露光を行なうと、感光成分１では、波長λ２には感度があるが波長λ５には感度が無いため、波長λ５によって形成される光強度分布には関係なく、波長λ２によって形成された光強度分布の像が潜像となる。これとは逆に、感光成分２では、波長λ５には感度があるが波長λ２には感度が無いため、波長λ２によって形成される光強度分布には関係なく、波長λ５によって形成された光強度分布の像が潜像となる。このとき、レジストは潜像反応濃度が入射光強度に対し非線形な感度特性を有しているので、解像限界を越える微細なパターンが得られる。

【００２１】なお、第４実施例中では、異なる波長の光を用いて同時に一括露光を行なったが、異なる波長毎に非同時に露光を行なうことも可能であることは言うまでも無い。また、感光成分１と感光成分２との波長感度特性が、上記λ１，λ２，λ３，λ４，λ５，λ６の順に波長が大きくなるものだけではなく、λ４（感光成分２の短波長端）＜λ３（感光成分１の長波長端）となる場合でもλ４（感光成分２の短波長端）＞λ２（レーザーＬ１からの露光波長）且つλ５（レーザーＬ２からの露光波長）＞λ３（感光成分１の長波長端）というレジストを用いれば、上記の第４実施例と同じ結果が得られる。

【００２２】

【発明の効果】このように、本発明によれば、正確な位置合わせを必要とするレチクルやウエハの横ずらしやレチクル交換などを行うことなく、２つあるいはそれ以上の独立した像を感光素材上に形成することができ、被投影原版交換の必要性が大幅に減じられることになる。

【図面の簡単な説明】

【図１】本発明における露光装置

【図２】第１実施例におけるレチクルの概略断面構成図

【図３】第１実施例における像面上の光強度分布

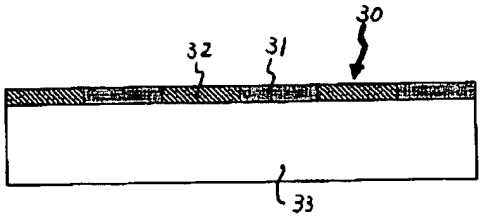
【図４】第２実施例におけるレチクルの概略断面構成図

【図５】第２実施例における像面上の光強度分布

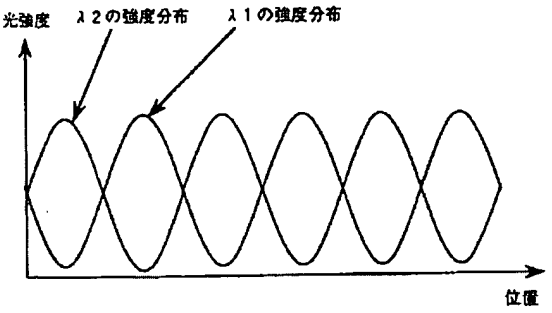
【図６】第３実施例におけるレチクルの概略断面構成図

【図７】第４実施例における感光素材の波長特性の図

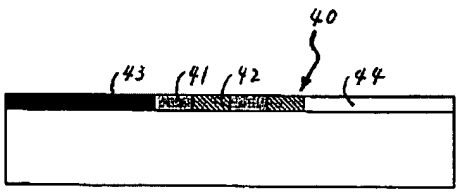
【図２】



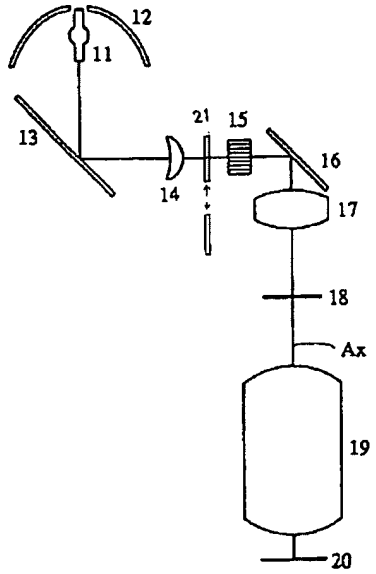
【図３】



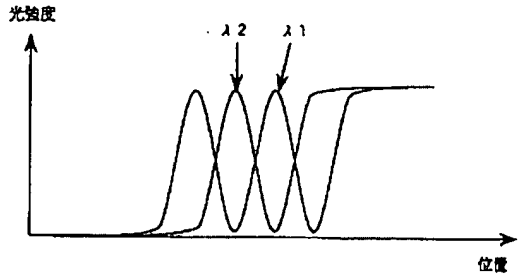
【図４】



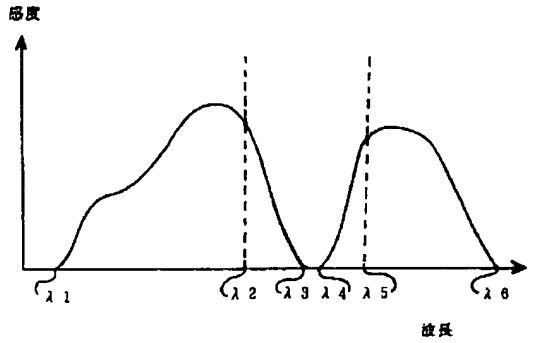
【図1】



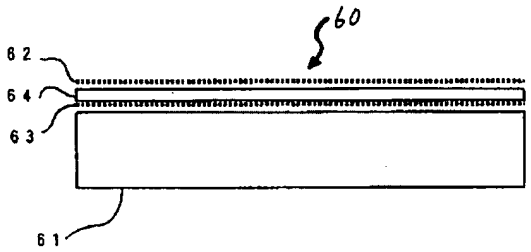
【図5】



【図7】



【図6】



フロントページの続き

(51)Int.Cl.⁶	識別記号	庁内整理番号	FI		技術表示箇所
G03F 7/20	521				
		7352－4M	H01L 21/30	514 C	
		7352－4M		515 D	

(72)発明者　小沢　稔彦
東京都千代田区丸の内3丁目2番3号　株式会社ニコン内